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Investigation of phase transitions in multiferroics $HoFe_{3-x}Ga_x(BO_3)_4$ and $TbFe_{3-x}Ga_x(BO_3)_4$ solid solution with huntite structure

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Crystals of the $RFe_3(BO_3)_4$ family with a structure like natural mineral huntite were reported to possess multiferroic features, demonstrating both structural and magnetic phase transitions [1-3], where transition points may be varied by substituting as rare earth element as a magnetic ion. We present the Raman spectroscopy result of the investigation of single crystals and a solid solution of $HoFe_{3-x}Ga_x(BO_3)_4$ and $TbFe_{3-x}Ga_x(BO_3)_4$.

Temperature measurements were performed in the temperature range 10-400 K. This study aims to investigate the possible existence of a soft mode related to structural order parameter and effects of magnetic transitions on Raman spectra. Analysis of the experimental Raman spectra, temperature dependences of the provisions of the centers of lines, their width and relative intensity was carried out, as well as theoretical temperature approximation for some lines. Some anomalies in the temperature dependences of the spectral lines associated with the occurrence of magnetic order. It was found that significant changes are observed in the spectrum of low-frequency range (below 100 cm^{-1}) – there is a mode corresponding to two-magnon scattering. The structural phase transition accompanied condensation of soft mode (Fig. 1).

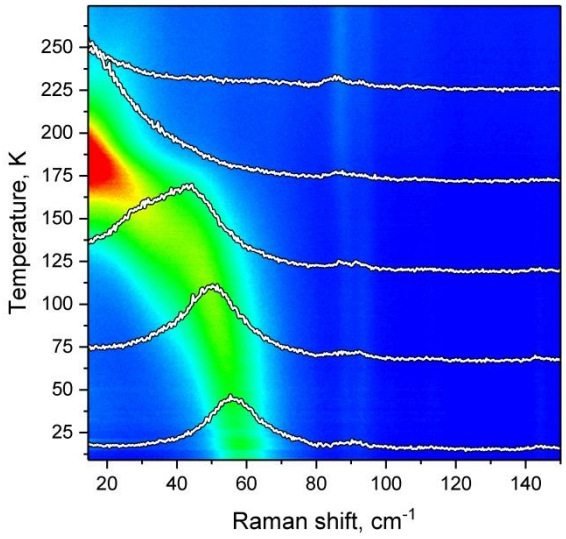

Figure 1. Raman intensity map and spectra transformation of soft mode condensation at $HoFe_2Ga(BO_3)_4$.

The phase diagram Temperature – Composition has been acquired for $HoFe_xGa_{3-x}(BO_3)_4$ solid solution. Structural transitions manifest clearly by soft mode restoration, and abnormal changes of line position indicate a temperature of magnetic ordering.

The most promising composition for future extensive investigation is $TbFe_{2.5}Ga_{0.5}(BO_3)_4$. This solid solution has magnetic and structural phase transition below 45 K. The strong coupling between these the two ferroic orders expected.

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1. A.S. Krylov et al. *Solid State Commun.* **174**, 26 (2013).
2. E. Moshkina et al. *Cryst. Growth. Des.* **16**, 6915 (2016).
3. A.S. Krylov et al. *Journal of Advanced Dielectrics* **8**, 1850011 (2018).